ing this most fascinating question, which I venture to put before the Royal Society. Although I cannot pretend to an intimate acquaintance with the more intricate phenomena of solar physics, I have long had a conviction derived principally from familiarity with some of the terrestrial effects of heat, that the prodigious and seemingly wanton dissipation of solar heat is unnecessary to satisfy accepted principles regarding the conservation of energy, but that it may be arrested and returned over and over again to the sun, in a manner somewhat analogous to the action of the heat recuperator in the regenerative gas furnace. The fundamental conditions are :—

1. That aqueous vapour and carbon compounds are present in stellar or interplanetary space.
2. That these gaseous compounds are capable of being dissociated by radiant solar energy while in a state of extreme attenuation.
3. That these dissociated vapours are capable of being compressed into the solar photosphere by a process of interchange with an equal amount of reassociated vapours, this interchange being effected by the centrifugal action of the sun itself.

If these conditions could be substantiated, we should gain the satisfaction that our solar system would no longer impress us with the idea of prodigious waste through dissipation of energy into space, but rather with that of well-ordered self-sustaining action, capable of perpetuating solar radiation to the remotest future.

FURTHER OBSERVATIONS ON THE FRESH-WATER MEDUSA, MADE DURING THE SUMMER, 1881

1. THE Freshwater Medusa—*Limnocodium Sowerbii*—reappeared in the lily-house tank in the Botanical Gardens, Regent's Park, during the summer of 1881, as the readers of NATURE were duly informed.

In spite of the renewed opportunities for study thus afforded, the life-history of this interesting organism still remains a mystery, and it is still exceedingly difficult to frame any hypothesis as to the original introduction of the jelly-fish into the tank where it was discovered by Mr. Sowerby in 1880.

The only general hypothesis which can be entertained as to the original introduction of the jelly-fish, is that it came "in some way at some time" with plants deposited in the tank.

It is *improbable* that the jelly-fish can have existed for many seasons in the tank unobserved, though *possible*, supposing that it first appeared in small numbers.

The last importation of an aquatic plant into the lily-house in Regent's Park, previous to the discovery of the jelly-fish in June, 1880, is that to which suspicion naturally attaches itself. This importation occurred early in March, 1879, when, as Mr. Sowerby kindly informs me, a Miss Tupper, whose address is not in his possession, presented to the Royal Botanical Society a specimen of a species of *Pontederia*. This specimen was wrapped in a piece of brown paper, was about one foot long, was crushed and as dry as hay, in fact the Garden superintendent and the man in charge of the tank thought it dead. The specimen is believed to have come from Brazil. It vegetated after being placed in the tank, and has given rise to a copious growth, part of which is now in the lily-house of the Botanic Garden at Oxford.

Mr. Sowerby cannot remember the introduction of any new plants into the tank at such time previous to this as would render it probable that the jelly-fish were introduced on such previous occasions.

It is clear, then, that if the jelly-fish were introduced with the *Pontederia*, either the animal itself or its eggs must have great power of resistance to partial desiccation. Of this power of resistance we have no further evidence, for the tank in the Lily-house is not completely emptied and dried in the winter, though the water is run off, a deep trough of water and mud remains permanently at one end of the tank.

At the same time it is in accordance with what is known as to many lacustrine animals that the eggs or young stages of the fresh-water jelly-fish should be able to resist partial desiccation. Hence the theory of its introduction with the *Pontederia* is, though far from demonstrated, yet quite tenable. Plants of this *Pontederia* were sent from Regent's Park to Kew and Oxford (where they are flourishing) some months before the discovery of the jelly-fish in June, 1880. But no jelly-fish made their appearance in consequence (so far as is known) in the tanks at Kew and Oxford. Hence the association with the *Pontederia* of the eggs or young of the jelly-fish cannot have been a very intimate one.

2. The history of the jelly-fish in the Regent's Park tank is as follows :—It was first seen by Mr. Sowerby on June 10, 1880. At that time there were some specimens nearly full-grown and a vast number of very young ones (apparently recently hatched) also. By the end of July not a specimen could be found in the tank. All the mature specimens examined by me in 1880 were males, numbering 150. I entirely failed to obtain any specimen which was female, either young or mature. Nevertheless Mr. Sowerby was of opinion that young were produced by adult individuals isolated and kept by him in a small glass jar. These young were those which I reported on in the *Quart. Journ. Micr. Sci.*, January, 1881. I could find only adult males in the jar with them, and think that it is possible (though not certain))that the young were hatched from eggs floating in the water when first introduced into the jar. They would thus be only *late-hatching* members of the same brood of which adults were discovered on June 10. It is, on the other hand, possible that they belonged to a second generation.

The males observed in 1880 discharged abundant motile spermatozoa from their genital sacs and were obviously ready for procreation.

Thus in 1880 we were left in ignorance of the female of *Limnocodium*, and in nearly complete ignorance as to the period and mode of reproduction.

3. In 1881 Mr. Sowerby observed the Medusæ again, only two days after the anniversary of their first appearance, namely, on June 16. He states, in a letter kindly written for me, that only a "few were seen, although the water appeared swarming with minute individuals just large enough to be distinctly seen with the naked eye. Many of these we determined by examination with a glass; they did not, however, appear to come to manhood, and about the 25th of June the whole of the Medusæ vanished."

It is obvious that some process of reproduction had taken place between June, 1880, and June, 1881, giving rise to the Medusæ observed in 1881. Where were the females which produced the eggs from which this new generation was born? As in 1880, so in 1881, when first observed in June, *both minute young apparently just hatched*, and also *full-grown individuals were simultaneously detected*. In 1881 I examined about fifty of the full-grown individuals from the Regent's Park : as in 1880 they were all males. It seems probable that the adults observed on June 10 were merely early-hatched members of the same brood as the young (of various ages and sizes) which abounded with them.

From the experience of these two years it appears probable that the first specimens which hatch out must do so six weeks or two months before the middle of June. But as to the character of the eggs from which they hatch, we have as yet no idea. It would seem likely that those eggs were deposited before the emptying of the tank in December, and probably enough in the summer before the dying down of the males, so abundant until their total disappearance at the end of July.

But since the females have never been seen, it is possible that they have a slightly different form and habit from that of the males, or possibly a *very* different form —perhaps hydroid! In either case the females may have existed in the deeper parts of the tank either floating or attached, and so have escaped observation, whilst the high-swimming males were taken in abundance. The eggs may have been fertilised in August by the dying males, and have proceeded to a certain stage of development in the autumn—being then normally arrested in development in the winter (the period corresponding to the emptying of the tank and to a period of drought in their natural condition), as in the case of *Hydra viridis*. Then they would be ready to enter upon a new period of development and growth in the following spring and early summer.

4. The above suggestion is eminently hypothetical, and is somewhat difficult to reconcile with the result of the interesting experiment carried out at the suggestion of Mr. George Busk, F.R.S., in consequence of which some of the Medusæ were transferred in 1881 from the Regent's Park to the Victoria tank, in No. 10 house, at the Royal Gardens, Kew. This transfer was effected on June 16, four days after the second appearance of the Medusæ at Regent's Park. It is important to notice (as I am informed by Mr. Sowerby) that only six or eight full-grown Medusæ were so transferred—and I cannot feel much doubt that these were all males—similar to all those which I have examined. But with these half-dozen full-grown specimens, a quart of water containing many hundreds of very minute Medusæ was also taken. The flask of water and the little and big Medusæ were poured out into the large tank at Kew on the same day—June 16.

Nothing was seen of them at Kew until *more than two months afterwards*, when (on August 18) the whole tank was seen to be swarming with full-grown *Limnocodium*.

The question which arises is: Were these Medusæ simply the young Medusæ which had been transferred, now grown to maturity; or were they a new generation?

The chief objection to the view that the Medusæ swarming at Kew in August were the same Medusæ which were transferred in the young state from Regent's Park two months before, is found in the fact of their extraordinary abundance. I removed and examined myself at the end of September, from the tank at Kew, 200 specimens. Other naturalists also obtained numerous specimens. In the meantime, be it remembered, the whole colony had *died down or disappeared* (as early as June 25) *from the original tank in the Regent's Park!*

I am inclined to the view that the Kew Medusæ were actually the same specimens as those transferred in the young state, which were placed in more favourable conditions at Kew than their fellows experienced in the Regent's Park. The tank at Kew is larger than that in Regent's Park, food is therefore more abundant, and moreover the temperature was, when I observed it, from six to ten degrees Fahrenheit lower in the tank at the former than in that at the latter locality (75°-80° Kew, as against 85°-90° Regent's Park).

A fact which is strongly against the supposition that the transferred Medusæ had reproduced themselves is that the half-dozen mature specimens transferred were almost certainly males, and that the young specimens had not more than time to grow to full size, and were not observed to have arrived at maturity in the interval.

I made renewed and careful examination of the Medusæ at Kew at the end of September and in the beginning of October, when I had the advantage, through the kindness of Sir Joseph Hooker, of making use of the admirable laboratory recently erected in the Gardens. The specimens were often appreciably larger than any I had previously obtained from Regent's Park (fully half an inch across the expanded disc). All the specimens examined (200 in number) proved to be males. At the end of September there were no young or very small specimens in the Kew tank. In studying the genital pouches of specimens taken on September 27 I found below the ectoderm an abundance of ripe spermatozoa; these escaped through the wall of the pouch, which very readily ruptured. Below this layer of ripe spermatozoa, and between them and the "structureless lamella" separating endoderm and ectoderm, I observed (as I had observed previously in specimens from Regent's Park) a firm colourless tissue consisting of small nucleated cells. It occurred to me that these might possibly be ova, and the Medusæ accordingly hermaphrodite. They had not the appearance of ova at this stage, but still I thought it possible that they were very young ovarian cells. I treated specimens with osmic acid, alcohol, and picro-carmine in succession, and cut sections of the genital pouches, with the result of satisfying myself that this dense tissue beneath the loose spermatozoa was *not* ovarian, but consisted simply of the mother-cells of the spermatozoa.

I further tested this view of their nature by isolating a number of the Medusæ in large glass jars which were kept in the lily-house at Kew. After a fortnight (October 8) the gonads or genital pouches had increased in length and bulk both in my isolated specimens, and in those swimming in the tank. On examination, the dense tissue underlying the spermatozoa was found to have disappeared, or rather to have developed itself into additional crops of spermatozoids. Accordingly my hypothesis of hermaphroditism fell to the ground.

It is, however, remarkable that even when half-grown the genital pouches of *Limnocodium* will emit ripe motile spermatozoids upon slight pressure, and that they continue to form these bodies for so long a period of growth. Normally, I am inclined to believe, these spermatozoa are shed by rupture of the sac in incompletely grown individuals, from time to time, whilst new crops are produced from the as yet unexhausted spermatic tissue. This would imply that somewhere in the tank there are eggs or females producing eggs which are to be fertilised by the very abundant spermatic particles.

The tank at Kew was emptied and thoroughly cleaned out about the middle of October. The Medusæ were still to be found, though they had much diminished in abundance. Some of the sweepings of the bottom of the tank were preserved with the intention of replacing the material in the tank, so that the eggs of the Medusæ—if eggs there are—may have a chance of continuing the colony in the coming season.

My object in publishing these notes is that they may be of service to others who may feel disposed to investigate *Limnocodium*, and to search for the females should opportunity again be afforded. I also hope that some suggestions may be offered by other naturalists, which will be of assistance in solving the problems presented.

It is necessary to point out that the obvious plan of searching the sediment of either the tank at Kew or in the Regent's Park for eggs is not feasible. The bulk of the material to be examined is too great, since these tanks have a square area of several hundred feet. There would be a better chance of finding the females (supposing them to be deep-living or sessile) in such a search than the eggs, were it possible to empty the tanks and get at the sediment when a suitable period for such search arrives. But, as a matter of course, the proper treatment of these tanks in connection with the cultivation of plants cannot be interfered with. An obvious suggestion is that of isolating a number of both old and young Medusæ in small tanks, and thus obtaining the means of knowing exactly what becomes of them and of anything they may produce. I have attempted this both in 1880 and 1881, but without any success. The Medusæ isolated, even in large bell-jars holding 5 or 6 gallons of water, and maintained at a temperature of 80° F., do not thrive.

After a time they die. Their ill-health under these circumstances is apparently due not merely to the want of food, since with sufficient trouble the small Entomostraca on which they feed can be supplied to them, but to the very fact of isolation in a small receptacle. They require a large bulk of water. Fluviatile organisms can be kept in a small vessel by means of a constant stream passed through the vessel, and organisms which inhabit small ponds present no difficulty. But lacustrine forms are very difficult to deal with. Should the Medusæ reappear this year, it is my intention (with the permission of the authorities) to partially submerge a vessel with freely perforated sides in the large tank, the bottom of such vessel to be imperforate, and the vessel itself two feet in diameter and three feet in depth. If a sufficient number of the first brood of young Medusæ can be cultivated in this vessel through the summer, both males and females (unless the females have some altogether unsuspected history) will in all probability arrive at maturity, and reproduce in it as they clearly enough have done in the Regent's Park tank between 1880 and 1881. It will then be possible from time to time to examine carefully the contents of this experimental vessel. I need not say that I should be very glad if others would carry out a similar experiment.

E. RAY LANKESTER

ELECTRICITY AT THE CRYSTAL PALACE

II.—*Edison's Electric Light*

THE centre of attraction at the exhibition of electricity in the Crystal Palace, formally opened on Saturday by the Duke and Duchess of Edinburgh, will unquestionably be the show of Mr. Edison. His electric light in the Entertainment Court and the Concert Room is by far the finest ever yet made, and is of itself a spectacle to be remembered. No expense has been spared to demonstrate the power and beauty of his incandescent lamps, and the divisibility of the current to meet the wants of domestic lighting; while Messrs. Verity and Sons have seized the occasion to illustrate their skill and show how eminently adapted the electric light is for ornamental purposes. The heated filament of carbon inclosed in a vacuous bulb of glass is well fitted for all kinds of domestic illumination by reason of its pure and absolutely steady glow, its healthiness and freedom from noxious fumes, and its comparative coolness. But in addition to its superiority over gas, oil, and candles in these respects, the Edison exhibit also proves in the most striking manner its superiority as a decorative light, and its unrivalled capacities for enhancing the artistic pleasures of our homes. Besides giving off no deleterious gases to tarnish gilding or dim the most delicate colours, the incandescent lamp lends itself to the designer's fancies in a way which no other illuminant can; and we may expect something like a revolution in household decoration by its introduction, as well as a new development of the brass-worker and the glass-blower's art.

Before considering the apparatus employed by Mr. Edison at the Crystal Palace for the production and distribution of the light, we shall briefly describe the results. To begin with the Entertainment Court, which is in reality a small theatre, the principal object of interest is a magnificent chandelier suspended from the middle of the ceiling. This beautiful object is in itself a work of art, and sustains ninety-nine incandescent lamps. It is conical in general shape, and is about fifteen feet in height by ten feet in diameter at the lower end; while its weight is half a ton. In device it represents a tapering bouquet of flowers rising out of a golden basket. The stem of each flower springs from a circular brass plate within the basket, and bends over towards the spectator, presenting to him its calyx of coloured glass, in which is fixed an incandescent lamp. The foliage is all of hammered brass, richly gilt, and here and there is mingled with the sun-flower or tiger-lily, and some rambling sprays of fern. The corollas of the flowers containing the lamps, and acting as their shades, are in the form of heaths and harebells, made of glass, and tinted with a variety of colours—pearl, white, ruby, clear olive, and clouded blue. Each lamp projects from the heart of the flower like an enlarged pistil, and throws its light outwards and downwards into the room below. The lights are controlled in three sections by turncocks, like gas, and thus a graduated effect can be obtained, or all the lights may be put on or off at will.

On each side of the stage, which is furnished with a row of twenty-four footlights, there is a pretty candelabra[1] mounted on a short marble column, and representing a rose-bush springing from a golden urn. The stem of the bush is entwined with China roses, and crowned with five upright lamps or candles, like the fruit of the tree. On the left of the stage is hung an exquisite little chandelier or lustre of Venetian glass, which, though far less imposing than its gaudier neighbour in the centre of the hall, is chaster and more elegant, and better fitted for an ordinary drawing-room. It is about four feet high, and consists of loops and festoons of crystal drops on gilded chains, encircled at the bottom by a ring of fourteen lamps; and inclosing higher up a single incandescent bulb of ruby glass under a bell shade of the same material. The use of coloured glass for the vacuous bulb itself is illustrated here, and shows how the light can be tinted to harmonise with any interior furnishing, or suit the taste and eyesight of individuals. The brilliance of the glowing carbon in a transparent bulb is not too strong for the ordinary eye to look at with impunity; but persons of weak sight may have it reduced by the use of clouded bulbs, and students, or those suffering from diseases of the eye can employ bulbs of green or blue glass. Photographers, too, can have recourse to ruby lamps in the development of their negatives.

On the right side of the stage there is a third chandelier of gilt brass, with twelve naked bulbs, a number of single lamps on stands or movable brackets, like gas-jets, with turn-cocks, and either naked or shaded by flat conical reflectors of opal glass. Specimens of these are shown in Figs. 1 and 2. Then there are hall-lanterns of brass, inclosing clusters of bulbs, window-lights, a very handsome billiard lamp, containing six set of twin lamps, shaded from the eyes of the players by opal glass reflectors and crimson fringes, and two handsome drawing-room shade-lamps of the same pattern, each containing a cluster of eight bulbs inside, and one being supplemented by four pairs of naked bulbs outside. Bulbs are also shown burning under water, either clear or tinted, to illustrate the use of the incandescent system in fiery mines, and there is a specimen of a regulator lamp by which the power of the jet can be graduated at will like a gas-flame, by simply turning the cock. This lamp is shown in Fig. 3, the lower being the regulator, which acts by inserting the resistance of a series of vertical carbon rods into the circuit. This is done by turning the screw-piece at the base of the cylinder inclosing the bars. The cylinder is perforated to allow the air to circulate and keep them cool.

In the top of the lamp the novelty is the form of the contact surfaces to prevent sparking or breaking the circuit. These are conical, the small cone seen on the top of the figure being forced away from a conical cup on turning the screw plug. The large surfaces of the cones prevent simultaneously separating, and prevent a large spark. A safe-guard for the lamp against a too powerful current is provided in a short lead wire, seen running across the left of the figure. When the current is too strong this wire fuses, and the current of the lamp is interrupted.

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[1] Electrolier and electrolabra would be the corresponding terms.